

WHAT IS CLAIMED IS:

1. A method of recovering and recycling a coolant gas containing contaminants, the method comprising:

providing a heat exchanger and an analyzer, the heat exchanger and the analyzer in operational association;

5 recovering the coolant gas containing contaminants from the heat exchanger;

delivering an analysis portion of the recovered coolant gas to the analyzer;

analyzing the analysis portion of the recovered coolant gas with the analyzer to determine a condition of the recovered coolant gas;

10 blending, based on the condition, a reclaimed portion of the recovered coolant gas and a virgin coolant gas to produce a gaseous coolant blend having a predetermined contaminant concentration; and

introducing the gaseous coolant blend into the heat exchanger such that at least a portion of the recovered coolant gas is recycled.

2. The method of Claim 1, wherein the method further comprises a step of introducing the virgin coolant gas into the heat exchanger prior to the recovering step.

3. The method of Claim 1, wherein the recovering step and the delivering step are performed by a single pump.

4. The method of Claim 1, wherein the method further comprises providing the analysis portion of the recovered coolant gas to a seal associated with the heat exchanger.

5. The method of Claim 1, wherein the method further comprises providing a seal for the heat exchanger using the recovered coolant gas.
6. The method of Claim 1, wherein the method further comprises providing a control system, the control system associated with the analyzer and operable to control the blending.
7. The method of Claim 1, wherein the analysis portion of the recovered coolant gas passes through the analyzer at a constant rate of flow.
8. The method of Claim 1, wherein the gaseous coolant blend is introduced into the heat exchanger at a constant rate of flow.
9. The method of Claim 1, wherein the method further comprises providing means for controlling an amount of contaminants introduced into the heat exchanger.
10. The method of Claim 1, wherein the method further comprises providing means for controlling a contaminant concentration in the gaseous coolant blend.
11. The method of Claim 1, wherein the method further comprises providing means for controlling a contaminant concentration in the gaseous coolant blend introduced into the heat exchanger.
12. The method of Claim 1, wherein the method further comprises dividing the recovered coolant gas into a portion of the recovered coolant gas that includes the analysis portion of the recovered coolant gas and the reclaimed portion of the recovered coolant gas.
13. The method of Claim 1, wherein the predetermined contaminant concentration of the gaseous coolant blend is user defined.

14. The method of Claim 1, wherein the method further comprises maintaining a flow of a portion of the recovered coolant gas through a by-pass section.

15. The method of Claim 14, wherein the method further comprises simultaneously decreasing the flow of the portion of the recovered coolant gas through the by-pass section and increasing the flow of the reclaimed coolant gas through the blending section.

16. The method of Claim 14, wherein the maintaining the flow of the portion of the recovered coolant gas through the by-pass section reduces lag time.

17. A method of recovering and recycling a coolant gas containing contaminants, the method comprising:

providing a heat exchanger and an analyzer, the heat exchanger and analyzer in operational association;

5 recovering the coolant gas containing contaminants from the heat exchanger;

delivering an analysis portion of the recovered coolant gas to the analyzer;

analyzing the analysis portion of the recovered coolant gas with the analyzer to determine a condition of the recovered coolant gas;

10 blending, based on the condition, a reclaimed portion of the recovered coolant gas and a virgin coolant gas to produce a gaseous coolant blend having a predetermined contaminant concentration; and

introducing the gaseous coolant blend into the heat exchanger such that at least a portion of the reclaimed recovered coolant gas is recycled.

18. A method of controlling a contaminant concentration in a gaseous coolant blend provided to a heat exchanger, the method comprising:

providing the heat exchanger and an analyzer, the heat exchanger and the analyzer in operational association;

5 recovering a coolant gas containing contaminants from the heat exchanger;

delivering an analysis portion of the recovered coolant gas to the analyzer;

analyzing the analysis portion of the recovered coolant gas with the analyzer to determine the contaminant concentration within the recovered coolant gas; and

10 blending, based on the contaminant concentration, a reclaimed portion of the recovered coolant gas and a virgin coolant gas to produce the gaseous coolant blend;

recycling the reclaimed portion of the recovered coolant gas by introducing the gaseous coolant blend into the heat exchanger such that the contaminant concentration in the gaseous coolant blend provided to the heat exchanger is controlled.

19. The method of Claim 18, wherein the method further comprises introducing a portion of the recovered coolant gas into a by-pass section, the by-pass section providing a seal to the heat exchanger and ensuring continuous operation of a pump.

20. An apparatus for use with a heat exchanger, the apparatus comprising:

a coolant recovery section for recovering a coolant gas containing contaminants from the heat exchanger;

an analysis section operable to monitor a condition of the recovered coolant gas; and

5 a coolant gas blending section in operational association with the coolant gas recovery section and the analysis section, the coolant gas blending section operable to produce, based on the condition of the recovered coolant gas, a gaseous coolant blend having a predetermined contaminant concentration from a virgin coolant gas and a reclaimed portion of the recovered coolant gas.

21. The apparatus of Claim 20, wherein the coolant gas recovery section comprises a pump operable to produce both a negative pressure and a positive pressure within the apparatus.

22. The apparatus of Claim 20, wherein the coolant gas recovery section comprises an orifice capable of reducing, within the heat exchanger, the effects of pressure differentials created by the pump.

23. The apparatus of Claim 20, wherein the coolant gas blending section comprises a means for controlling flow.

24. The apparatus of Claim 23, wherein the means for controlling flow is selected from the group consisting of a first and second flow controller, a first and second mass flow controller, and a first and second valve.

25. The apparatus of Claim 20, wherein the virgin coolant gas contains less than about 0.005 percent contaminants by volume of the virgin coolant gas.

26. The apparatus of Claim 20, wherein the predetermined concentration of the contaminants is less than about 5 percent contaminants by volume of the gaseous coolant blend.

27. The apparatus of Claim 20, wherein the condition is selected from the group consisting of an amount of moisture, a concentration of oxygen, and a concentration of an inert gas in the recovered coolant gas.

28. The apparatus of Claim 20, wherein the analysis section includes an analyzer selected from the group consisting of an oxygen analyzer, an inert gas analyzer, and a moisture analyzer.

29. The apparatus of Claim 20, wherein the apparatus further comprises a by-pass section for providing a gas seal to the heat exchanger.

30. The apparatus of Claim 29, wherein the by-pass section utilizes at least a portion of the recovered coolant gas to provide the gas seal.

31. An apparatus for recovering a coolant gas containing contaminants from a heat exchanger and recycling at least a portion of the recovered coolant gas, the apparatus comprising:

a pump operable to recover the coolant gas from the heat exchanger and to transport the recovered coolant gas through the apparatus;

5 an analyzer operable to monitor a condition of the recovered coolant gas;

a first mass flow controller operable to reclaim a portion of the recovered coolant gas by delivering the reclaimed portion of the recovered coolant gas to a mixing point;

a second mass flow controller operable to provide a virgin coolant gas to the mixing point;

10 a third mass flow controller operable to maintain a flow of the recovered coolant gas through the apparatus;

wherein the apparatus is operable to produce, based on the condition of the recovered coolant gas, a gaseous coolant blend from the virgin coolant gas and the reclaimed portion of the recovered

coolant gas such that the gaseous coolant blend has a predetermined contaminant concentration when the gaseous coolant blend is introduced into the heat exchanger.

32. The apparatus of Claim 31, wherein a combined flow of recovered coolant gas through the first mass flow controller, the third mass flow controller, and the analyzer determine a pressure generated by the pump for transporting the recovered coolant gas.

33. The apparatus of Claim 31, wherein a flow of the recovered coolant gas passing through the analyzer is constant.

34. The apparatus of Claim 31, wherein the flow of the recovered coolant gas through the third mass flow controller is restricted while the flow of the recovered coolant gas through the first mass flow controller is simultaneously increased.

35. The apparatus of Claim 31, wherein the apparatus further comprises a control system associated with the analyzer and capable of actuating the first mass flow controller, the second mass flow controller, and the third mass flow controller based on the condition of the recovered coolant gas.

36. The apparatus of Claim 31, wherein the apparatus further comprises a control system associated with the analyzer and capable of actuating the first mass flow controller and the second mass flow controller to produce the gaseous coolant blend at the predetermined concentration.

37. The apparatus of Claim 31, wherein the apparatus further comprises an orifice for de-coupling the pump and the heat exchanger and reducing, within the heat exchanger, pressure differential effects produced by the pump.

38. A coolant gas recovery system comprising:

a coolant gas for cooling a hot fiber;

a heat exchanger including:

a fiber inlet adapted to receive the hot fiber into the heat exchanger;

a fiber outlet adapted to expel the hot fiber from the heat exchanger;

5 a passageway extending between the fiber inlet and fiber outlet, the passageway adapted to pass therethrough the hot fiber;

one or more coolant gas inlets for introducing a coolant gas into the passageway;

and

10 one or more coolant gas outlets for removing the coolant gas from the passageway;

a pump for pumping and drawing the coolant gas through the system;

an analyzer for monitoring an impurity concentration in the coolant gas;

a first mass flow controller and a second mass flow controller for controlling the impurity concentration in the coolant gas based on the monitored impurity concentration; and

15 a third mass flow controller for providing a seal to the heat exchanger using the coolant gas and for maintaining a constant flow of the coolant gas to ensure continuous operation of the pump.

39. The system of Claim 38, wherein the coolant gas is selected from the group consisting of helium, nitrogen, a helium-nitrogen mixture, and a helium-air mixture.